BITUMINOUS CONCRETE MIXTURE DESIGN

FIELD SAMPLING - 1961

APRIL 1962

NO. 12

by

F. MOAVENZADEH

W.H. GOETZ

Joint
Highway
Research
Project

PURDUE UNIVERSITY
LAFAYETTE INDIANA

Progress Report

BITUMINOUS CONCRETE MIXTURE DESIGN
FIELD SAMPLING - 1961

TO:	K. B. Woods, Director Joint Highway Research Project	April 11, 1962
FROM:	H. L. Michael, Associate Director Joint Highway Research Project	File: 2-12-5 Project: C-36-55E

Attached is a progress report entitled, "Bituminous Concrete Mixture Design - Field Sampling 1961," which has been prepared by F. Moavenzadeh and Professor W. H. Goetz of our staff.

The report presents results obtained for core samples taken on several bituminous resurfacing projects in the summer of 1961. The purpose of this continuing study has been to provide data for the application of the kneading compactor and Hveem design procedure to bituminous concrete mixture design in Indiana.

This is the third report containing data of this kind. The first is a report by N. G. Gaudette entitled, "Application of the Kneading Compactor and Hveem Stabilometer to Bituminous Concrete Design in Indiana," dated January 1961. The second is a progress report by N. G. Gaudette and F. Moavenzadeh entitled, "Bituminous Concrete Mixture Design - U. S. 52 at Lafayette" and is dated November 1961.

The report is submitted for the record.

Respectfully submitted,

Harold L Michael

Harold L. Michael, Secretary

HLM:cw

Attachment

cc: F. L. Ashbaucher
J. R. Cooper
W. L. Dolch
W. H. Goetz
F. F. Havey
F. S. Hill
G. A. Leonards
J. F. McLaughlin
R. D. Miles
R. E. Mills
M. B. Scott
J. V. Smythe
J. L. Waling
E. J. Yoder

Progress Report

BITUMINOUS CONCRETE MIXTURE DESIGN
FIELD SAMPLING - 1961

by

F. Moavenzadeh
W. H. Goetz

Joint Highway Research Project

Project: C-36-55E
File: 2-12-5

Purdue University
Lafayette, Indiana

April 11, 1962

Progress Report on Bituminous Concrete Mixture Design

In continuance of the attempt to establish a suitable Hveem design procedure to be employed in the design of Indiana bituminous mixtures under heavy traffic conditions, a series of core specimens was taken from five different highways in the summer of 1961. The selection of the highways was based on the age of highway which varied from three to five years, and composition of the mixture. Two of the highways, SR 43, and SR 13 had the same design asphalt contents, while the other three varied in kind of aggregate from crushed stone in SR 18 to gravel in U. S. 36. The general locations of cored sections are shown in Figure 1, and complete information regarding the type and sources of materials can be found in the enclosed "Record of Construction".

At each section three positions were selected which were 500 feet apart, and at each position two sets of cores, each including five specimens were taken. One set of cores was taken between wheel tracks and the other in the wheel tracks. The detailed sketch of each section is shown in Figures 2 to 6. A 4-in. inside diameter diamond bit was used for drilling. Figures 7 to 11 show a close view of sections. Reflection cracks and some fat spots are shown in Figure 8 and Figure 9 for sections of U. S. 36 and U. S. 136.

After drying the samples at room temperature for a few days, the composite height of each core was measured, and the surface and binder layers were separated by cutting at the interface with

a masonry saw using a diamond blade. The height of each layer was determined and laboratory tests were performed in the following sequence:

a. Hveem stability on built-up specimens of binder

b. Hveem stability on built-up specimens of surface

c. Bulk density on both surface and binder layers

d. Rice specific gravity on surface and binder

e. Percent asphalt content by extraction for binder and surface material

f. Aggregate gradation for all samples from which asphalt was extracted.

Table 1 presents the layer height, Hveem stability bulk density, maximum density, percent voids, and percent asphalt content for surface and binder core samples. In Figures 12 to 16 the results of these tests are presented graphically.

The sieve analysis results are presented in Table 2. Table 3 presents test results for specimens formed by recompacting surface and binder samples in the laboratory. Representative samples of the mixtures were used to determine their characteristics with respect to variation in compactive effort. The kneading compactor was used to prepare specimens 2.5 inches high and 4 inches in diameter using a variable number of tamps and variable foot pressure. Bulk density and stability were measured on the specimens so prepared. Figures 17 to 19 present the results of tests on recompacted samples.

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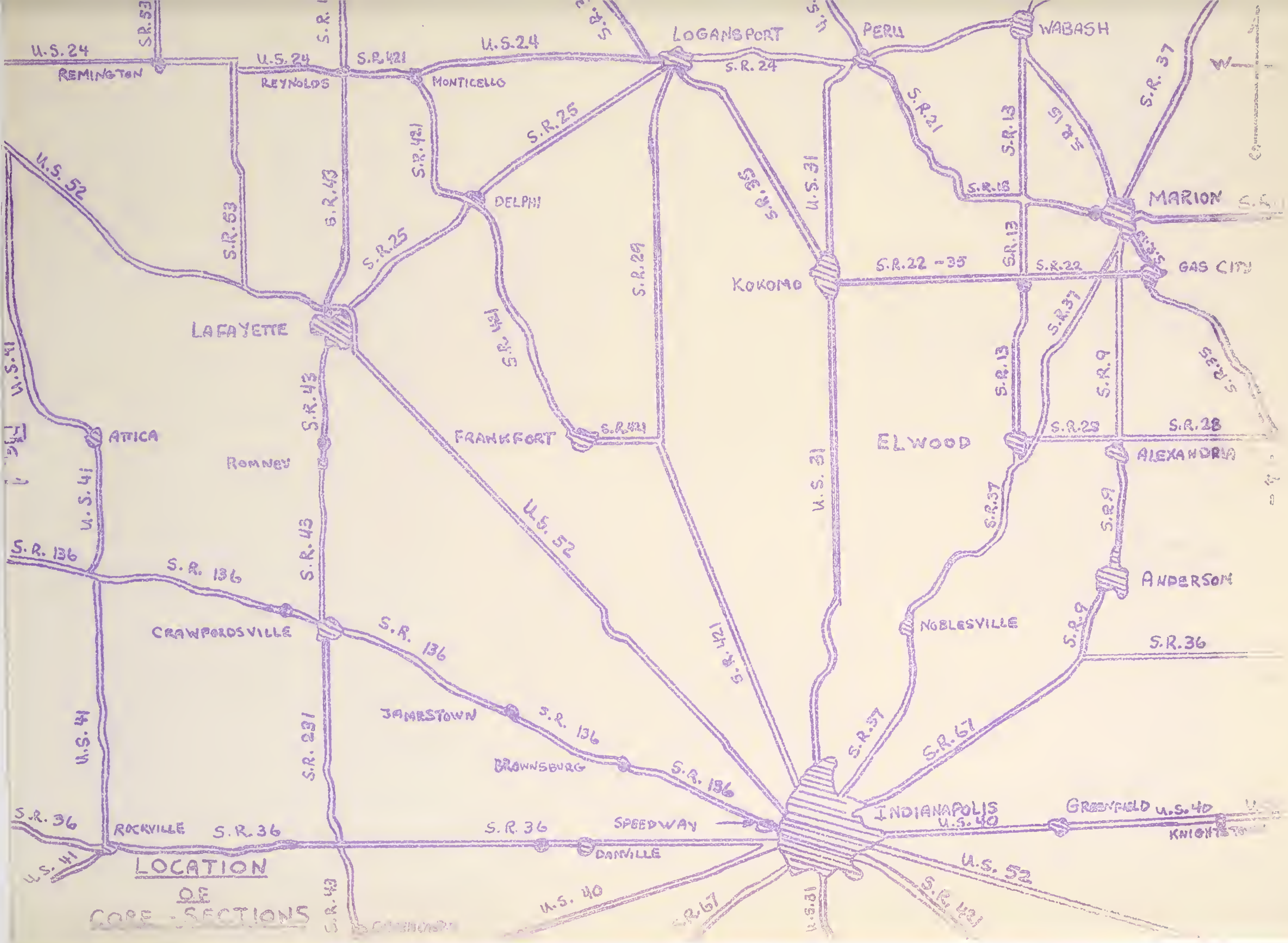
http://www.archive.org/details/bituminousconcre00moav



LOCATION OF CORE SECTIONS

RECORD OF CONSTRUCTION

ntract No. RS-4238 Awarded October 4, 1957 Bonded Idemnity Ins. Co. of North America

ocation From Nickle Plate RR (inden) to South City Limits f Lafayette, Indiana Cont. Completed Sept. 2, 1958 Proj. Engr. Karl Laurimore

Amount of Contract for this Road $413,480.36 Inspector: K.D.Rhodes
J.E.DeVault
G.Balkema

unty Montgomery & Tippecanoe Total Work Done: $380,551.59

ad No. 43 Sec. J & K Contractor Traylor Brothers, Inc.

Awarded-Miles 13.628 Sys. 191877

Built-Miles 13.418 Sys. 188936

CONTRACT COST DATA (Major Items)

Proposal Items	Unit Price	Cost Per Mile	Cost Per Syd.
. Agg. for Comp. Base (Widening)	$3.00	$2,114.60	$0.150
. HA Conc. Base (Widening)	6.54	9,378.45	0.666
. HA Conc. Binder No B	6.54	8,992.42	0.638
. HA Conc. Surface, Type "B"	6.85	4,106.88	
Cost (All Items) Per Mile		$23,361.27	$2.01

SOURCE OF MATERIALS (Specific Locations)

If material is from different sources show station numbers for each source.

Material	Company	Sources	Station to Station
' 5	Allby Asphalt Co.	Hammond, Ind.	Entire Project
: 150	Fauber Construction Co.	Lafayette, Ind.	" "
l Stone	Monon Stone Co.	Monon, Ind.	575+50 to 1152+35
l Stone	Delphi Stone Co.	Delphi, Ind.	0+00 to 177+16
, Agg.	Western Ind. Gravel Co.	Lafayette, Ind.	Entire Project
3 Agg. & #8 Agg.	" " " "	"	" "
.7 Sand	" " " "	"	" "

PAVEMENT DATA		First	Second	Third	Fourth
ype of Course		Base Widening	Bit Widening	HAC Binder	HAC Surface
idth (Feet and Inches)		2-36"	2-33"-2-29"	24'-0	24'-0"
ea (SYS.)				*180467	188936
ickness (Inches)		4"	9"	1 3/4"	3/4"
it. Mat'l (Gals./lbs. @ SYD.)					
ade and	Prime AE		150	150	
ind of	In Course		AP 5	AP 5	AP 5
it. Mat'l.	Seal		(none used)		
gregate Size		#63	#4	#8	#11 Stone
lbs. per SYD				170	80

ecial Remarks:
*From Station 145+40 to Station 177+16 (3176') Binder was not required

Karl M. Laurimore 9-11-58 Approved: Lloyd E. Poindexter
Engr. or Insp. Date Dist. Engr. Date

RECORD OF CONSTRUCTION

ontract No. RS-4212 Awarded August 26, 1957 Bonded Standard Accident Ins. Co.

ocation New Winchester to Cont. Completed Dec. 23, 1957 Proj. Engr. K. E. Thompson

est Corporation limit of Amount of Contract for this Inspector R. Franklin

anville Road $ 169,438.20

ounty Hendricks Total Work Done: $ 164,175.70

oad No. 36 Sec. F Contractor McMahan Illinois Corp.

Awarded-Miles 6.097 Sys. 85,845

Built-Miles 6.097 Sys. 85,845

CONTRACT COST DATA (Major Items)

Proposal Items	Unit Price	Cost Per Mile	Cost Per Syd.
1. Concrete Patches	15.00	1,008.69	15.00
2. Bit. Mat. for Underseal	60.00	811.19	
3. Agg. for Comp. Agg. Base Widening	3.85	2,678.65	
4. H.A. C. Base for Widening	6.65	9,475.57	
5. H. A. C. Base	6.75	439.30	
6. H. A. C. Binder	6.40	7,772.90	0.54
7. H. A. C. Surface Type "B"	7.15	4,022.62	0.29
8. Steel Beam Guard Rail	3.45	325.36	
	Cost (All Items) Per Mile	26,927.00	1.91

SOURCE OF MATERIALS (Specific Locations)

If material is from different sources show station numbers for each source.

Material	Company	Sources	Station to Station
nderseal	Standard Oil Co.	Whiting, Indiana	686+08 - 1008+00
RS-1	Asphalt Mat.	Indpls., Ind.	" "
omp. Agg. Base	Standard Mat	Plainfield Ind.	" "
AP 5	Pioneer Asphalt	Lawrenceville, Ill.	" "
4 & #11 Gravel	Standard Mat	Plainfield, Ind.	" "

PAVEMENT DATA		First	Second	Third	Fourth
ype of Course		Binder	Surface		
idth (feet and inches)		24.0'	24.0'		
rea (Sys.)		88220	85845		
hickness (inches)		1.7"	0.8"		
Bit. Mat'l (Gals./lbs. @ syd.)		.03			
Aggregate Size		#4	#11		
	lbs. per syd.	170	80		
Grade and kind of Bit. Mat'l.	Prime	RS-1			
	in Course	AP-5	AP 5		
	Seal	none	none		

Special Remarks:

By K. E. Thompson ____ Approved: L. E. Poindexter 1-27-58

Engr. or Insp. Date Dist. Engr. Date

RECORD OF CONSTRUCTION

Contract No. RS-4277 Awarded January 20, 1958 Bonded Stand Accident Ins. Co.

Location Waynetown to Crawfordsville on US 136 Cont. Completed Oct. 21, 1958 Proj. Engr. L. L. Cord

Amount of Contract for this Bid $261,120.62 Inspector W. H. Gibbs

County Montgomery Total Work Done: $248,510.93

Road No. US 136 Sec. Contractor Rieth-Riley Construction Co., Inc.

Awarded-Miles 8.968 Sys. 122909

Built-Miles 8.968 Sys. 124422

CONTRACT COST DATA (Major Items)

Pro Proposal Items	Unit Price	Cost Per Mile $	Cost Per Syd.
1. Concrete Patches	$15.00	809.50	15.00
2. Underseal	78.00	719.80	0.61
3. Comp. Agg. for Shoulders	3.60	1,926.80	0.90
4. Comp. Agg. for Base Widening	3.60	2,386.88	0.12
5. Prime	42.00	83.80	0.59
6. H.A.C. Binder	6.40	8,311.00	0.286
7. H.A.C. Surface	7.20	3,975.09	3.43
8. H.A.C. Widening	6.40	9,096.02	
	Cost (All Items) Per Mile	$27,710.65	

SOURCE OF MATERIALS (Specific Locations)

If material is from different sources show station numbers for each source.

Material	Company	Sources	Station to Station	
Concrete	Ready Mix, Crawfordsville	Interstate Gravel Co	564+00	80+79
AP-5	Poineer Products	Lawrenceville, Ill	"	"
#4 Stone	Russellville Stone Co.	Russellville, Ind	"	"
#11 Stone	" " "	" "	"	"
#17 Sand	Western Indiana	Montezuma, Indiana	"	"

PAVEMENT DATA	First	Second	Third	Fourth
Type of Course	Widening	Binder	Surface	
Width (feet and Inches)	27"	24 to 30	24' to 36'	
Area (Sys.)	23785	125528	124422	
Thickness (Inches)	13"	1.7"	0.8"	
Bit. Mat'l (Gals/lbs. @ Syd)	40.5 lbs.	7.65 lbs	3.6 lbs	
Aggregate Size	#4	#4	#11-17	
Lbs. Per Syd	444	170	80	
Grade and Kind of Bit. Mat'l — Prime in Course Seal	AP 5	AP 5	AP 5	

Special Remarks:

By L. L. Cord (Engr. or Insp.) ____ (Date) Approved: Lloyd E. Poindexter (Dist. Engr.) ____ (Date)

RECORD OF CONSTRUCTION

Contract No. RS-4217	Awarded September 6, 1957	Bonded Massachusetts Bonding & Insurance Co.
Location Just West of SR 13 to	Cont. Completed August 14, 1957	Proj. Engr. T. C. Lindsey
2.15 Miles West of SR 9 at	Amount of Contract for this	Inspector Dillion Gard
Marion	Road $ 169,396.70	
County Grant	Total Work Done: $ 173,897.88	
Road No. 18 Sec. J2J3	Contractor Mohr Construction Co., Inc.	

Awarded-Miles 6.191 Sys. 89,987

Built-Miles 6.191 Sys. 90,703

CONTRACT COST DATA (Major Items)

Proposal Items	Unit Price	Cost Per Mile	Cost Per Syd.
1. H. A. Conc. Surface, Type "B"	6.60	4,297.62	0.29
2. H. A. Conc. Binder	6.00	1,004.81	0.07
3. H. A. Conc. Base	6.00	7,509.44	0.51
4. H. A. Conc. Base for Widening	6.00	8,092.19	0.55
5. Comp. Agg. for Base Widening	3.20	1,966.72	0.13
6. Bituminous Material for Prime	42.00	217.77	0.01
7. Covering Aggregate	3.50	85.37	0.01
8. Concrete Base	6.00	1,710.55	0.12
Cost (All Items) Per Mile		28,088.81	1.92

SOURCE OF MATERIALS (Specific Locations)

If material is from different sources show station numbers for each source.

Material	Company	Sources		
AP-5	Standard Oil Co.	Whiting, Ind.	1120+51	- 1446+00
AE-150	Fauber Const. Co.	Lafayette, Ind.	"	"
#4 & #11 Stone	Pipe Creek Stone Co.	Mier, Ind.	"	"
#9 Stone	" " " "	" "	"	1175+00
#14 Sand	Irving Bros. Stone & Gravel	Marion, Ind.	"	"

PAVEMENT DATA		First	Second	Third	Fourth
Type of Course		Base Wid.	HAC Base	HAC Surface	
Width (feet and inches)		2' Ea. Side	24' to 37'	24' to 37'	
Area (Sys.)				(1) (2)	
Thickness (inches)		9" (3-3" layer)	2"	0.8 to 0.9	
Bit. Mat'l (Gals./lbs. @ Syd.)					
Aggregate Size lbs. per Syd.		#4	#4	#11 (2) (1)80 to 90	
Grade and Kind of Bit. Mat'l	Prime in Course Seal	AP 5	AE-150 AP 5	AP 5	

Special Remarks: (1) Sta. 1120+51 to 1175+00 (2) 1175+00 to 1446+00

By Theron C. Lindsey 8-25-58 Approved J. R. Hardendorf 9-17-58
Engr. of Insp. Date Dist. Engr. Date

RECORD OF CONSTRUCTION

ontract No. RS-3994 - Awarded May 31, 1956 Bonded Mass. Bonding & Ins. Co.

ocation On SR 13 from jct. Cont. Completed Oct. 2, 1956 Proj. Engr. O. C. Fox

S 35 N. approx. 5 mi. except Amount of Contract for this Road Inspector Arthur E. French
Raymond McGibbon

2,402' thru Swayzee Road $ 131,548.99

ounty Grant Total Work Done: $ 129,698.96

oad No. 13 Sec. Fa Contractor Mohr Construction Co., Inc.

Awarded-Miles 4.564 Sys. 64,272

Built-Miles 4.581 Sys. 65,256

CONTRACT COST DATA (Major Items)

	Proposal Items	Unit Price	Cost Per Mile	Cost Per Syd.
1.	Hot Asphaltic Conc. Binder	$ 6.79	$13,396.65	$ 0.940
2.	Hot Asphaltic Conc. Base for Widening	7.00	9,412.94	0.661
3.	Hot Asphaltic Conc. Surface Type "B"	8.00	4,482.34	0.315
4.	Subgrade Fine Aggregate	4.00	739.58	0.052
5.	Bituminous Material for Prime	40.00		
6.	Covering Aggregate	3.00		
7.	Castings Adjusted to Grade Monuments	10.00		
	Cost (All Items) Per Mile		$28,312.36	1.987

SOURCE OF MATERIALS (Specific Locations)

If material is from different sources show station numbers for each source.

Material	Company	Sources		
#4, 8, 9, 11, Stone	Pipe Cr. Stone Co.	Mier, Ind.	309+80 -	475+70
#17 Sand	Irving Bros. S & G Co.	Marion, Ind.	"	"
Paving Asphalt AP 5	Standard Oil Co.	Whiting, Ind.	"	"
Liquid Asphalt AE 150	Fauber Const. Co.	Lafayette, Ind.	"	"

PAVEMENT DATA		First	Second	Third	Fourth
Type of Course		Wedge	Widening	Binder	Surface
Width (feet and inches)		20' 0"	2-3 to 2-9	24' 00"	24' 00"
Area (Sys.)		53,111	12,191	64,173	65,256
Thickness (inches)		1"	9"	2"	3/4"
Bit. Mat'l (Gals./lbs. @ syd.)					
Aggregate size		#8	#4	#4	#11
	Lbs. Per Syd.	99.4	1010.3	199.4	78.7
Grade and Kind of Bit. Mat'l.	Prime	AE 150	AE 150		
	In Course	AP 5	AP 5	AP 5	AP 5
	Seal				

Special Remarks:

By ______________ ______________ Approved H. O. Martin 10-19-56
Engr. of Insp. Date Dist. Engr. Date

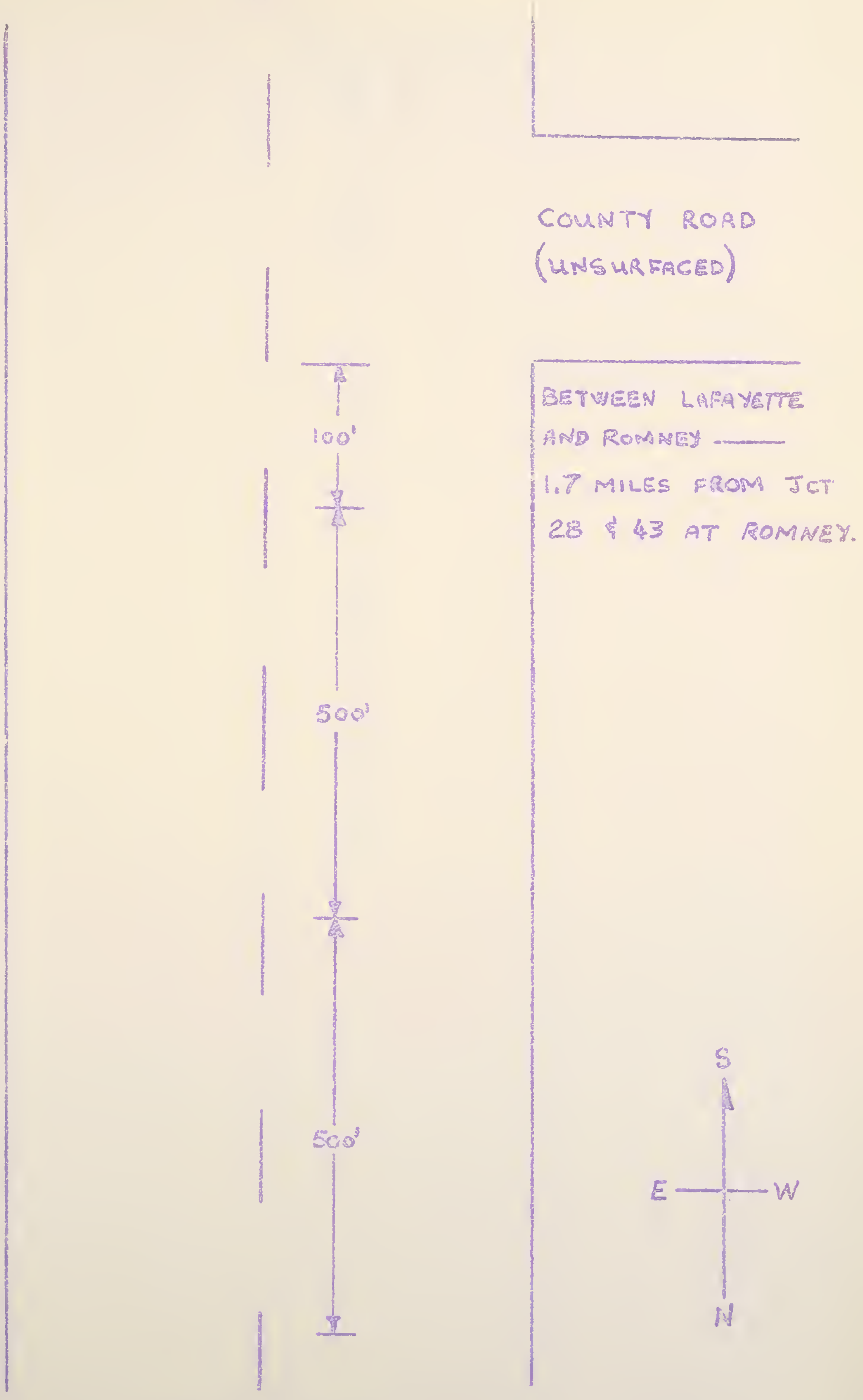

COUNTY ROAD
(UNSURFACED)
BETWEEN LAFAYETTE AND ROMNEY —— 1.7 MILES FROM JCT 28 & 43 AT ROMNEY.
100'
500'
500'
S
E
W
N
IND. 43 SOUTH

Fig. 2

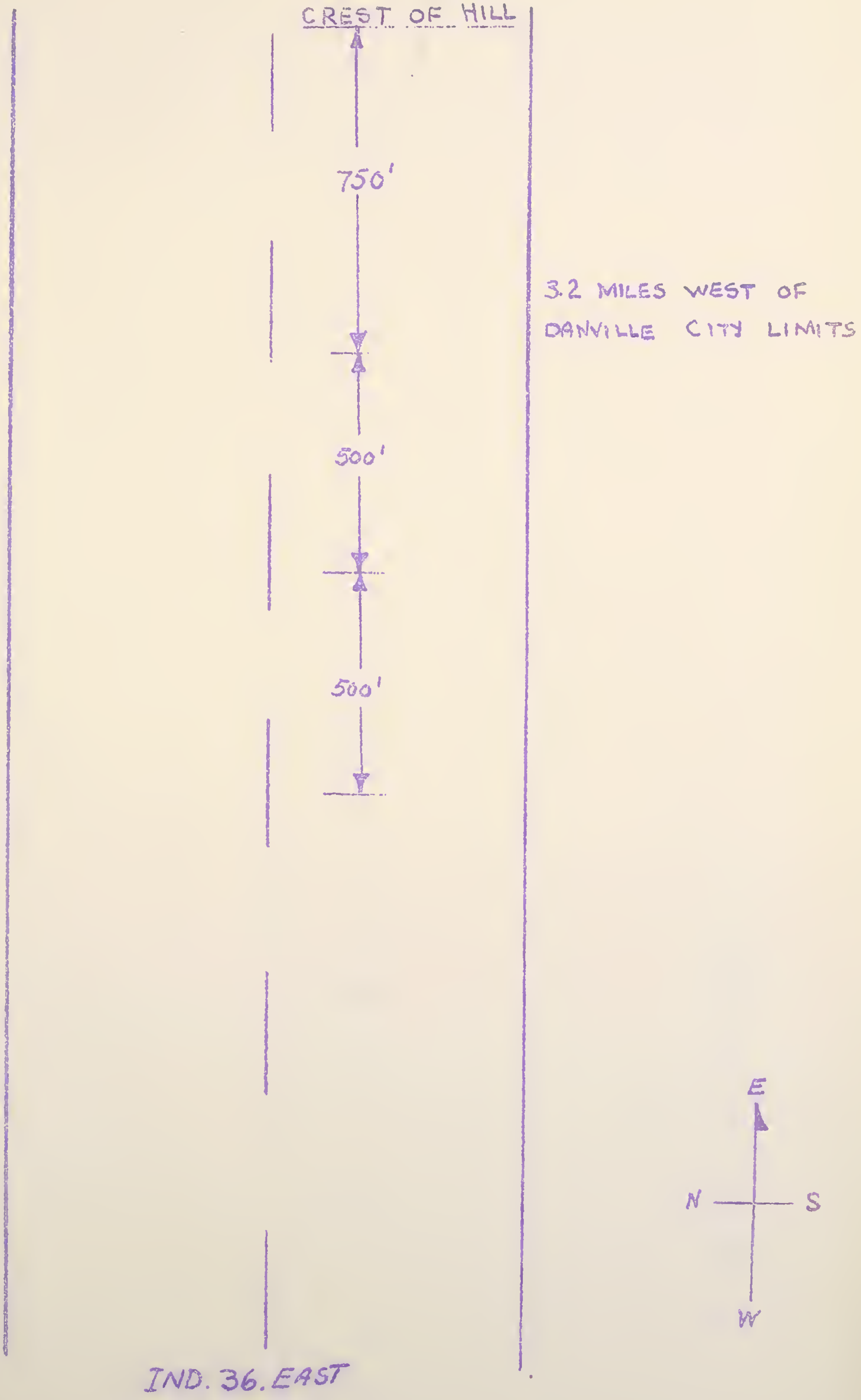

CREST OF HILL
750'
500'
500'
3.2 MILES WEST OF
DANVILLE CITY LIMITS
E
N
S
W
IND. 36. EAST

Fig. 3

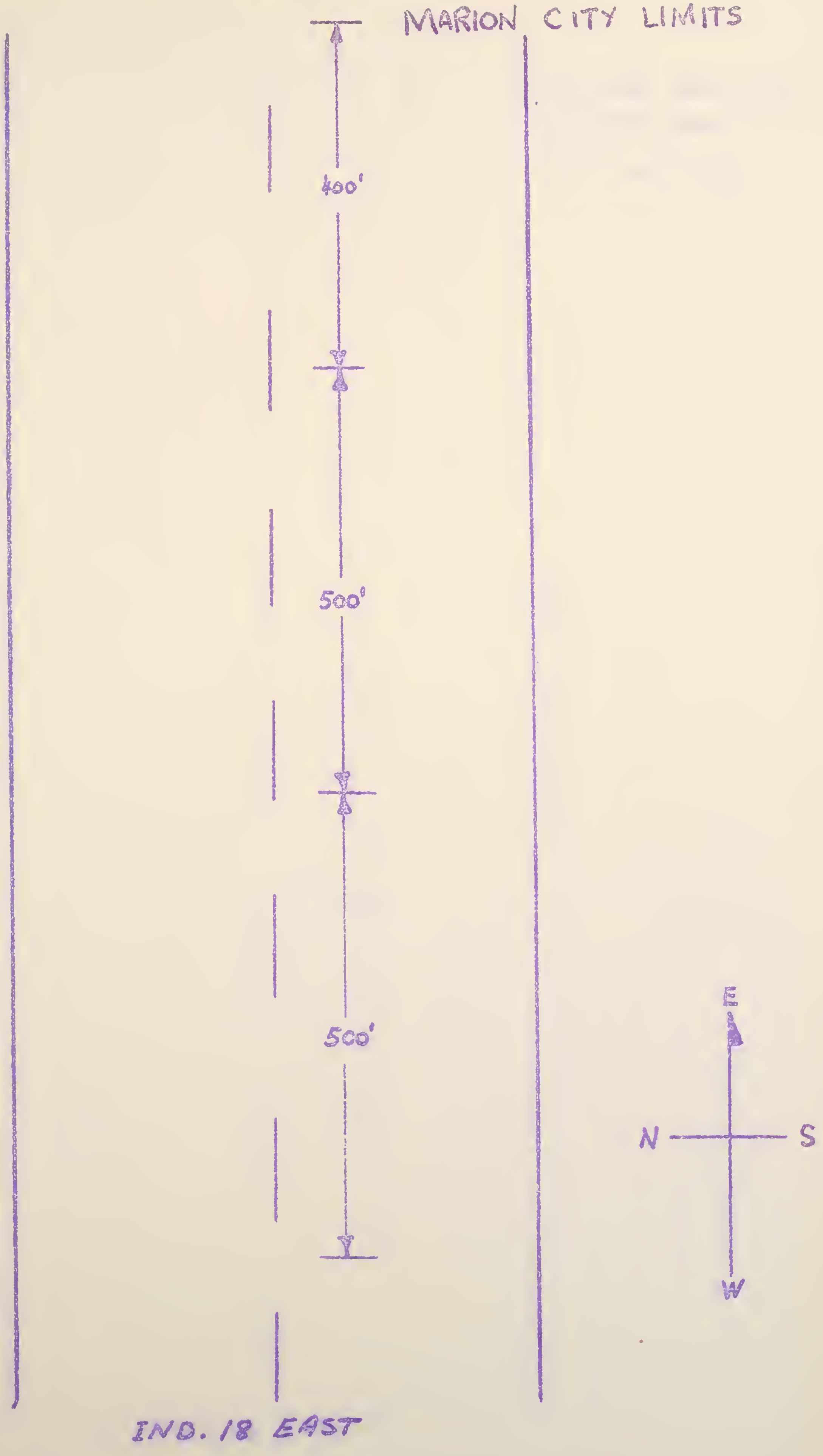
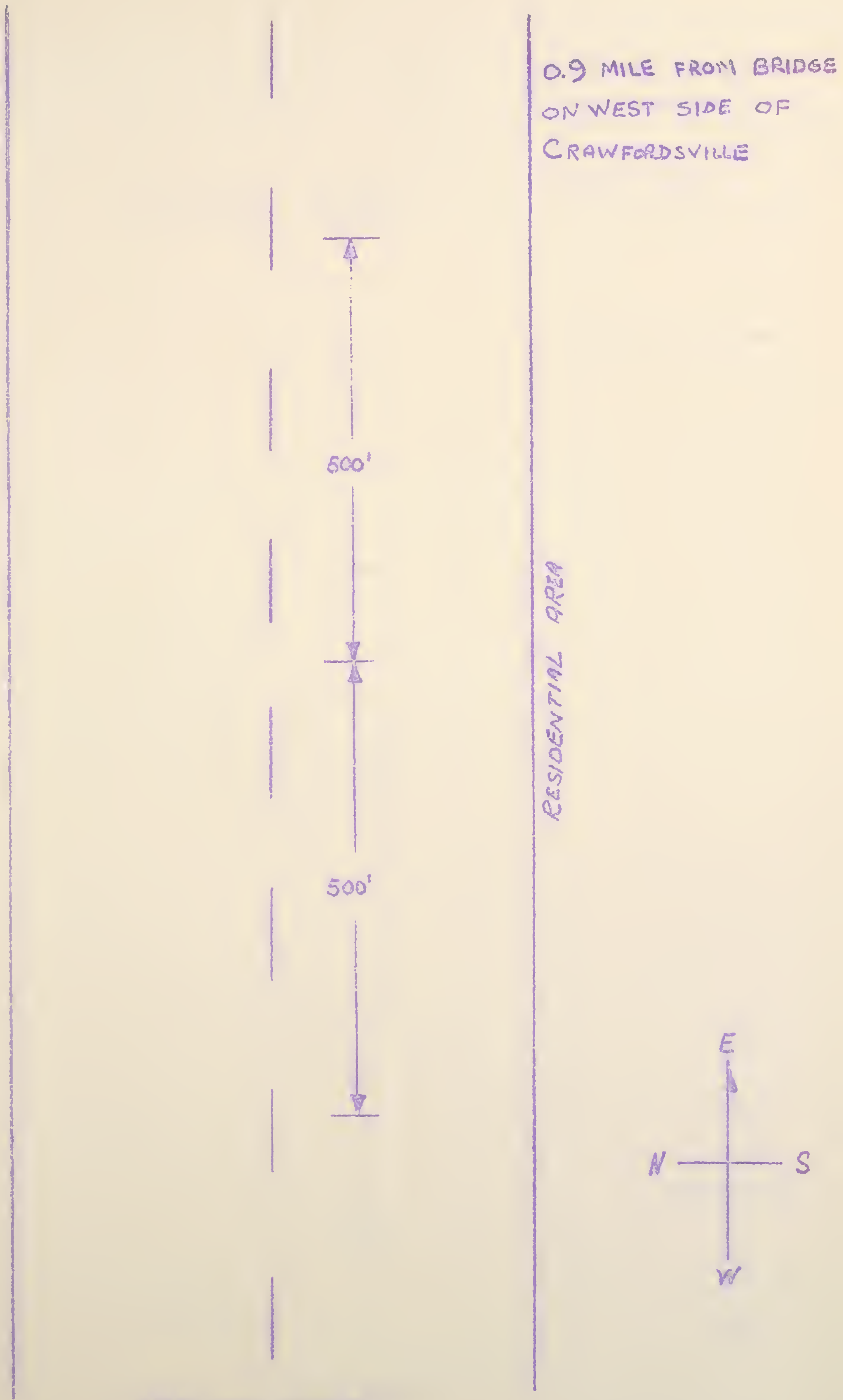


Fig. 5



IND. 136 EAST

Fig. 4

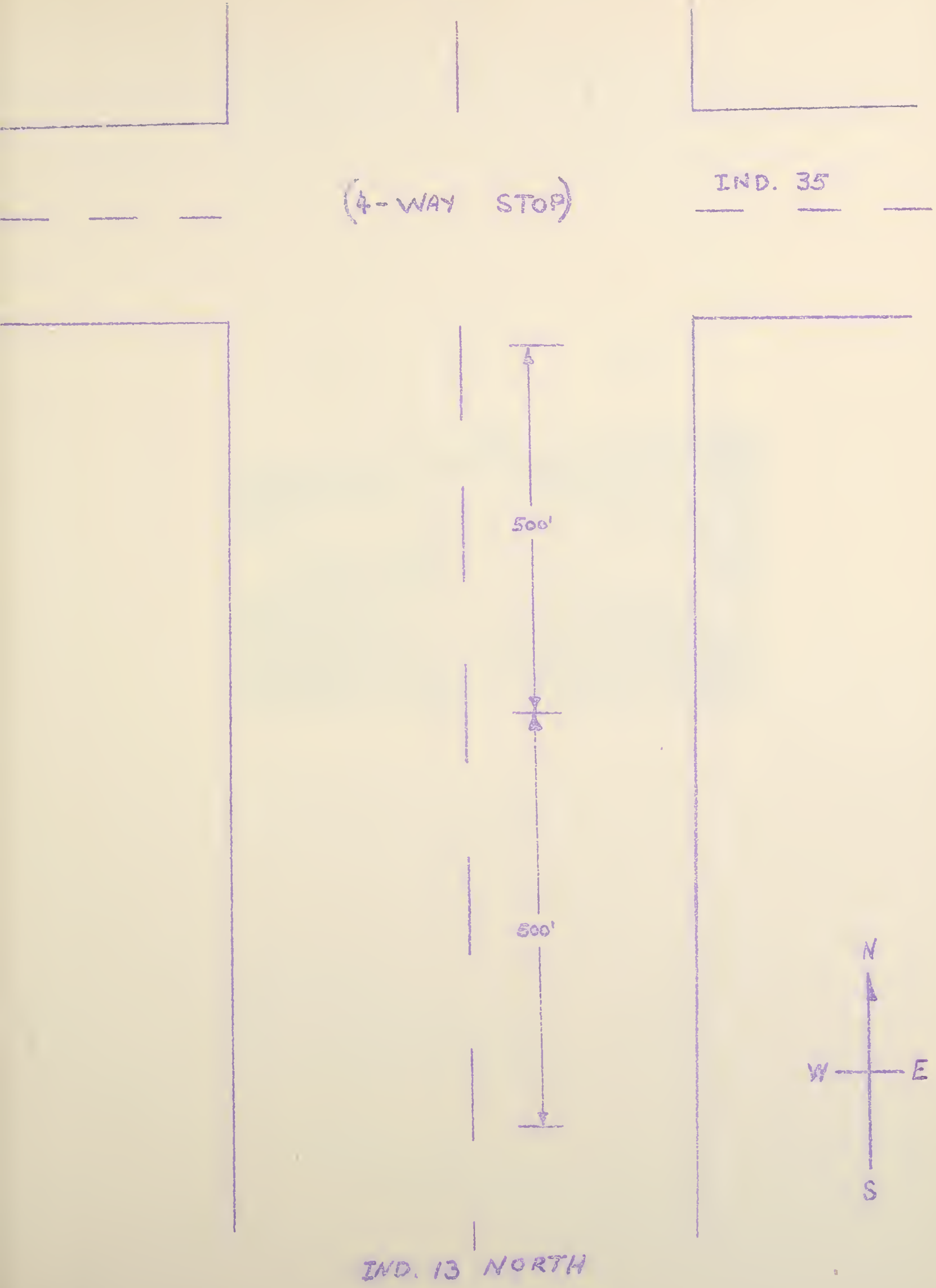
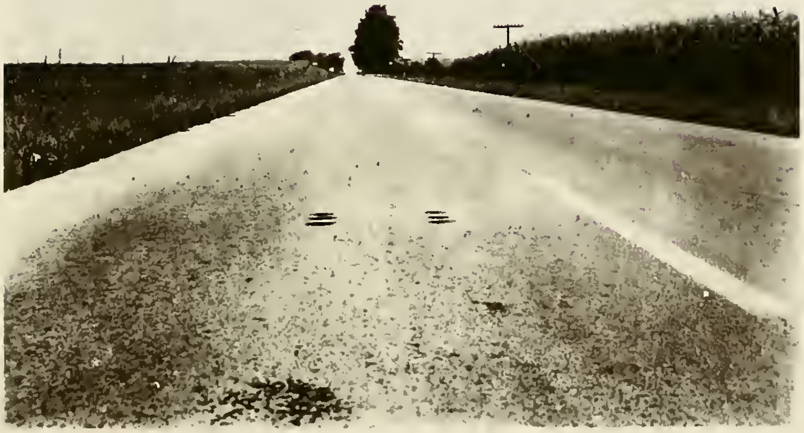


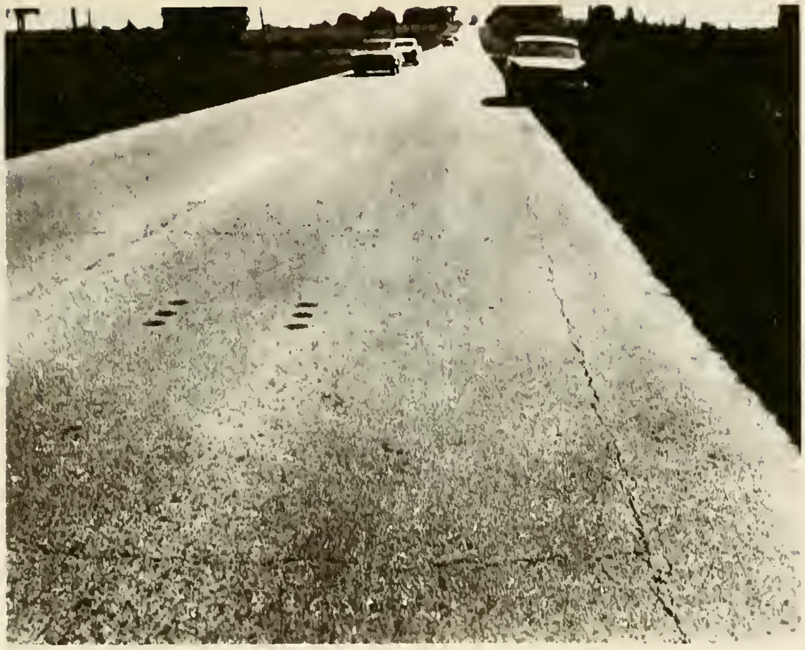
Fig. 6

N
S

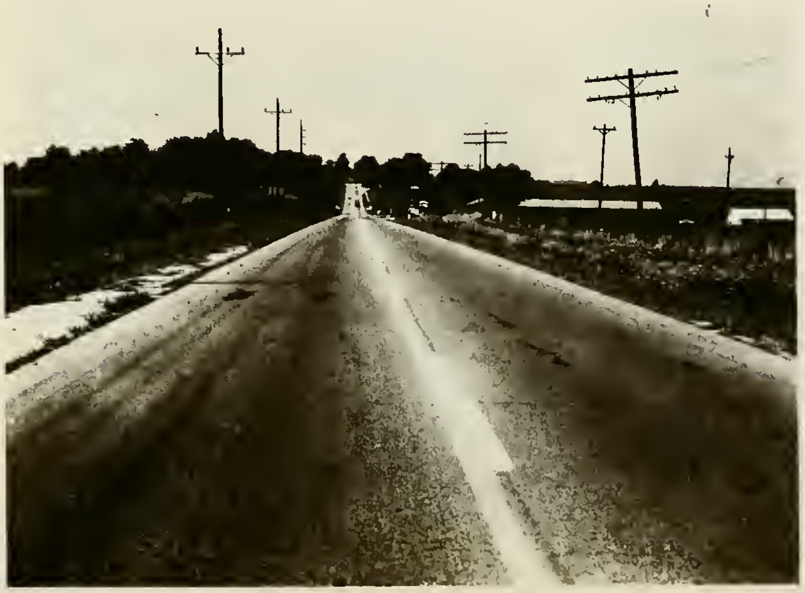


INDIANA 43

Fig. 7

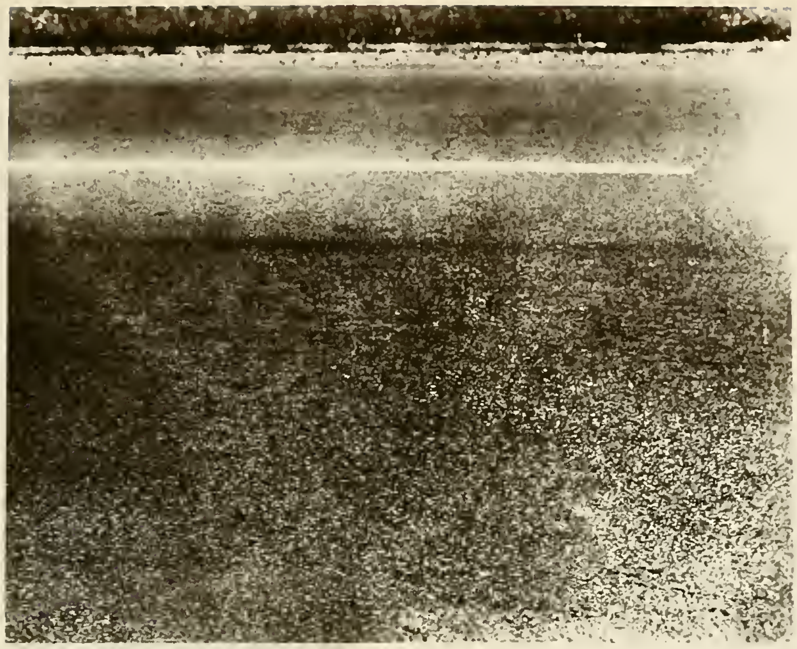


INDIANA 36 REFLECTION CRACKS

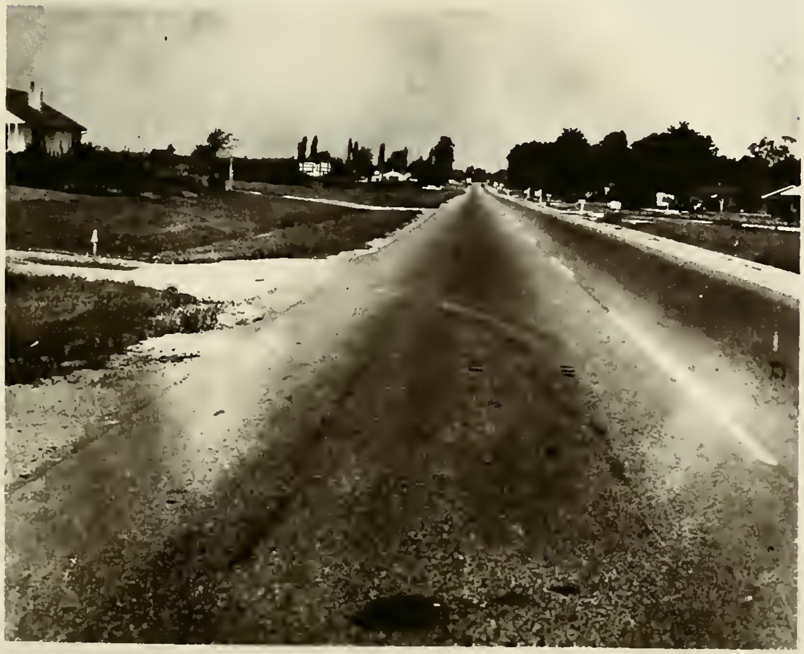


INDIANA 36 FAT SPOTS

Fig. 8

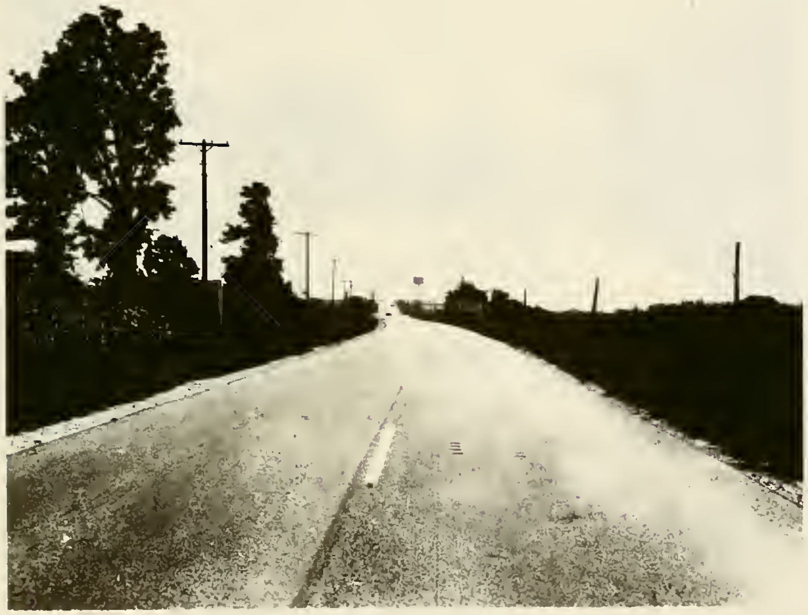


INDIANA 136 REFLECTION CRACKS



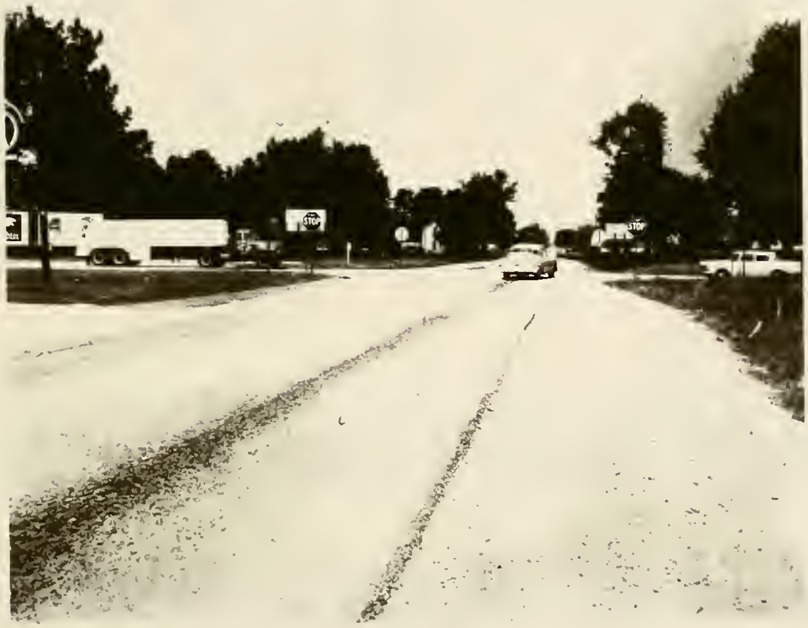
INDIANA 136

Fig. 9



INDIANA 18

Fig. 10



INDIANA 13 AT JCT. WITH IND. 35
Fig. 11

TABLE 1

TEST RESULTS ON CORE SAMPLES

Samples	Layer Hts., In.		Hveem Stability		Bulk Density, Pcf.		Max. Density, Pcf.		% Void		% Asphalt in Mix	
	Surface	Binder	Surface	Binder	Surface	Binder	Surface	Binder	Surface	Binder	Surface	Binder
Ind. 43 A 1	.61	2.16	23.0	22.4	149.8	150.3	155.0	152.0	3.35	1.18	6.45	5.4
2	.51	2.01	19.2	25.8	150.7	150.4			2.77	1.05		
B 1	.58	1.85	22.5	22.9	150.3	151.4	154.5	152.7	2.72	.85	6.60	5.3
2	.51	1.73	19.5	26.0	151.0	151.2			2.26	.97		
C 1	.62	1.79	21.7	21.7	151.1	152.3	154.9	153.0	2.45	.46	6.40	5.17
2	.57	1.69	21.4	25.7	151.5	151.4			2.19	1.04		
U.S. 36 A 1	.76	1.60	22.8	22.9	147.7	153.9	154.1	155.4	4.15	.96	5.65	4.5
2	.68	1.50	21.7	24.7	150.1	151.1			2.59	2.77		
B 1	.78	1.44	26.2	24.2	148.3	151.9	153.6	155.3	3.45	2.19	5.8	4.6
2	.74	1.45	21.9	25.1	150.6	154.6			1.95	.45		
C 1	.68	1.44	27.3	25.5	147.6	153.2	154.5	154.4	4.47	.78	5.55	4.8
2	.64	1.44	23.5	28.6	149.5	153.2			3.24	.78		
U.S.136 A 1	.69	1.53	28.3	29.1	147.8	150.3	152.0	153.4	2.76	2.02	6.80	4.80
2	.62	1.63	27.5	29.5	148.8	149.0			2.10	2.87		
B 1	.64	1.51	27.4	24.5	147.6	147.1	151.5	152.0	2.57	3.22	6.90	4.85
2	.63	1.38	23.5	25.8	149.2	148.8			1.52	2.10		
C 1	.62	1.47	28.4	29.7	148.2	148.9	152.5	151.9	2.82	1.97	6.80	4.9
2	.62	1.43	22.4	29.7	149.5	148.6			1.97	2.17		

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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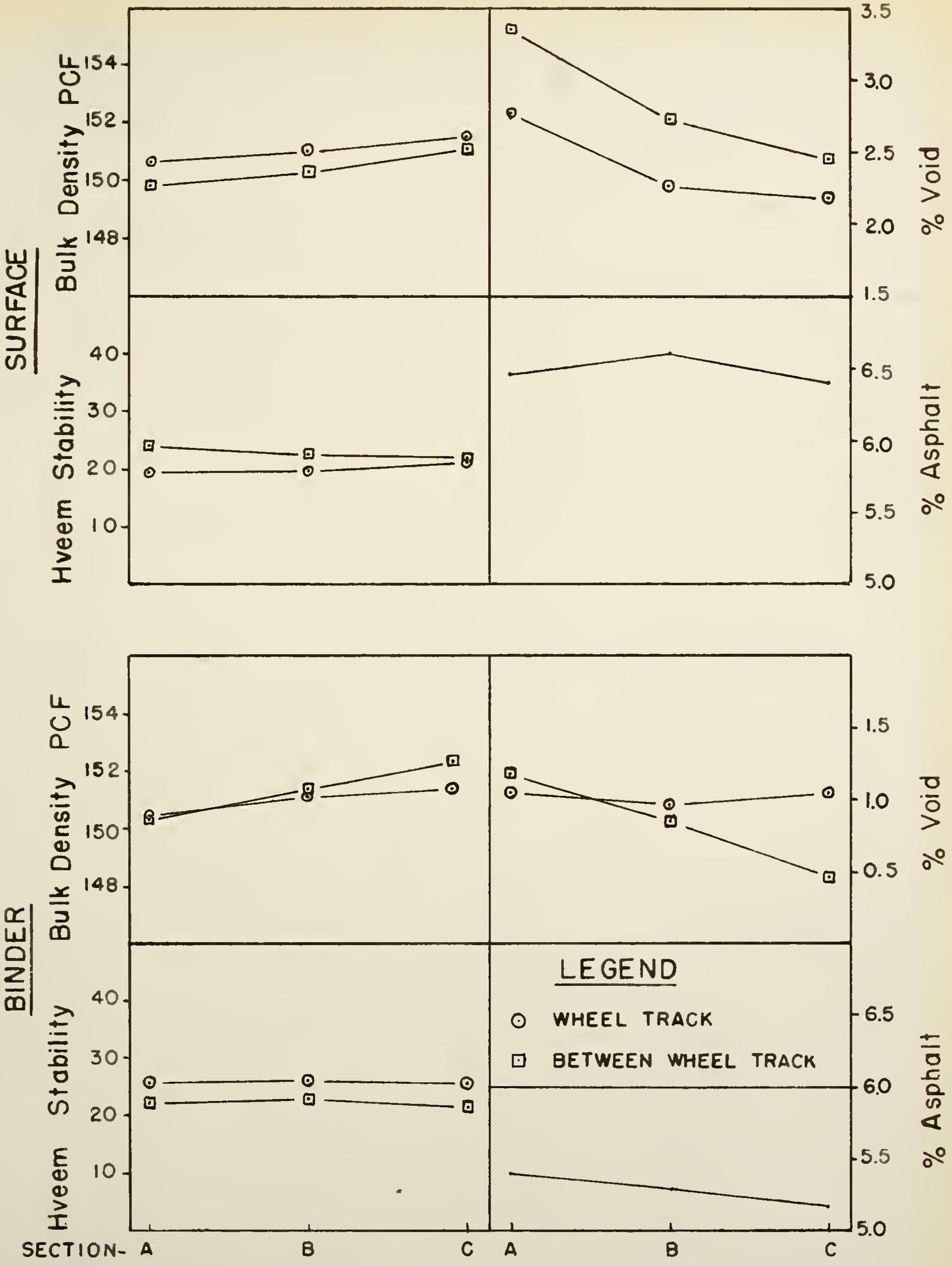
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE I. (continued)

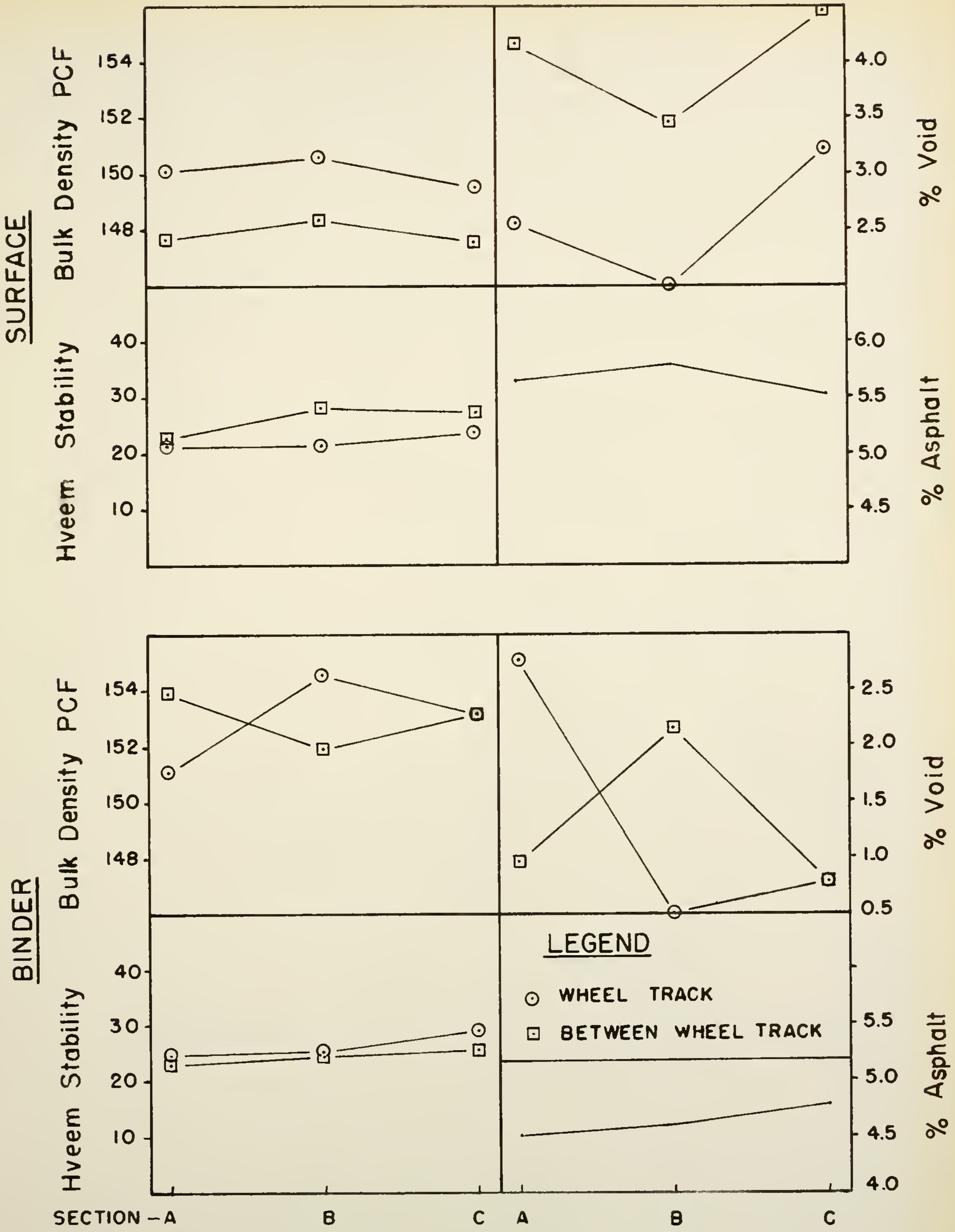
Samples	Layer Hts., In.		Hveem Stability		Bulk Density, Pcf.		Max. Density, Pcf.		% Void		% Asphalt in Mix	
	Surface	Binder	Surface	Binder	Surface	Binder	Surface	Binder	Surface	Binder	Surface	Binder
Ind.18 A 1	.67	1.58	23.6	30.9	147.8	148.9	151.0	153.0	2.12	2.68	6.7	5.8
2	.73	1.53	20.9	27.8	148.1	149.0			1.92	2.61		
B 1	.75	1.51	23.2	29.4	144.8	147.0	149.8	152.5	3.34	3.61	7.2	5.95
2	.80	1.67	20.8	29.9	146.5	150.7			2.27	1.18		
C 1	.90	2.00	24.4	28.8	147.4	150.7	152.2	153.8	3.15	2.01	6.1	5.6
2	.84	2.08	22.5	25.7	148.8	149.9			2.23	3.25		
Ind.13 A 1	.61	1.98	28.1	23.2	142.2	145.6	151.9	154.7	6.38	5.88	6.1	5.00
2	.64	1.86	25.6	24.7	143.2	145.6			5.73	5.88		
B 1	.87	2.12	29.2	25.9	142.0	148.2	151.7	155.0	6.39	4.39	6.1	4.90
2	.84	2.08	25.0	23.9	143.4	147.8			5.47	4.64		
C 1	.80	1.76	26.0	26.8	143.0	146.5	149.9	155.2	4.60	5.60	6.3	4.90
2	.72	1.97	23.6	27.6	144.3	146.0			3.73	5.93		

(1) between wheel track
(2) in the wheel track


SURFACE
Bulk Density PCF
154
152
150
148
% Void
3.5
3.0
2.5
2.0
1.5
Hveem Stability
40
30
20
10
% Asphalt
6.5
6.0
5.5
5.0
BINDER
Bulk Density PCF
154
152
150
148
% Void
1.5
1.0
0.5
Hveem Stability
40
30
20
10
% Asphalt
6.5
6.0
5.5
5.0
LEGEND
⊙ WHEEL TRACK
⊡ BETWEEN WHEEL TRACK
SECTION-
A
B
C
A
B
C

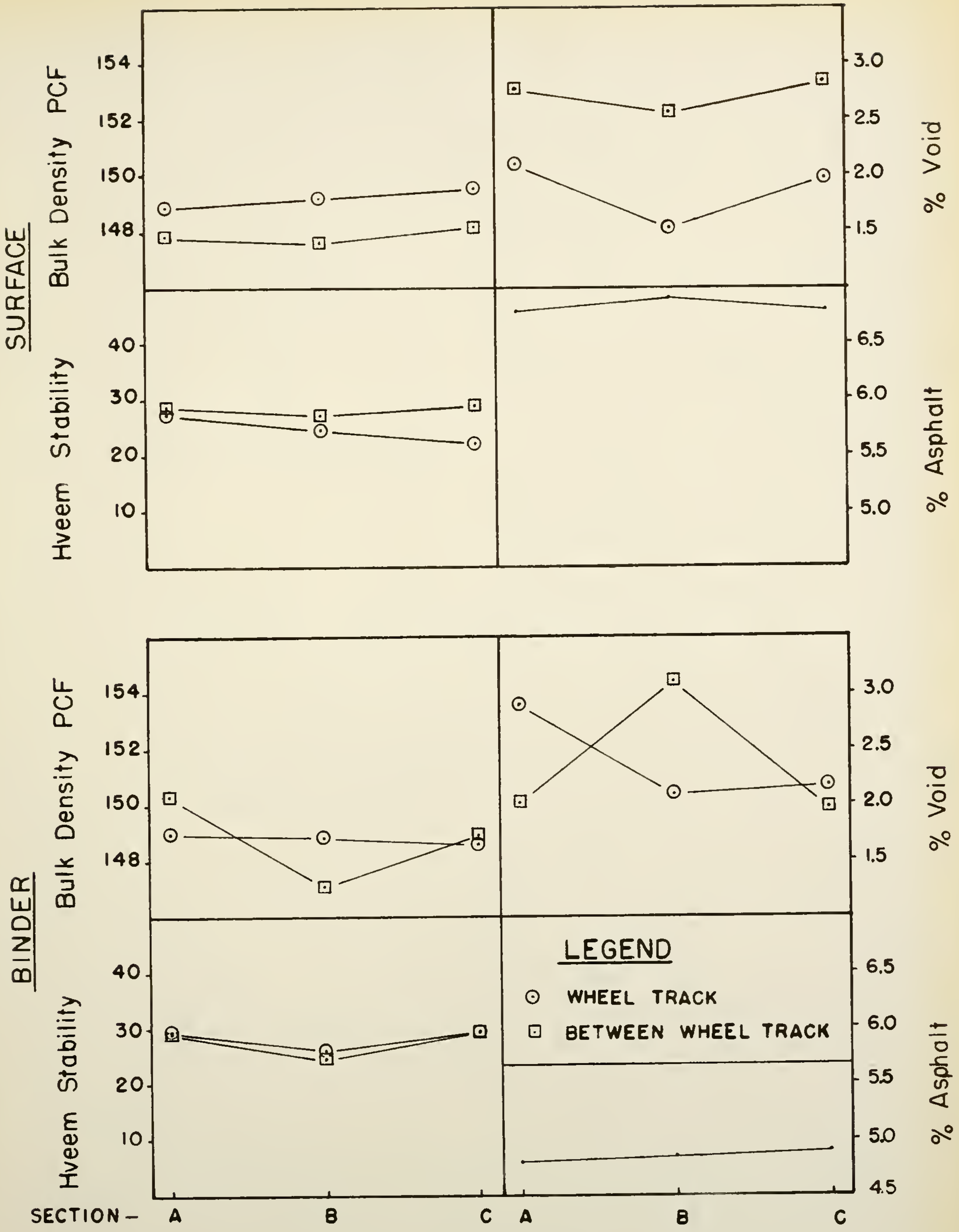
Ind. 43

Fig. 12


SURFACE
Bulk Density PCF
154
152
150
148
% Void
4.0
3.5
3.0
2.5
Hveem Stability
40
30
20
10
% Asphalt
6.0
5.5
5.0
4.5
BINDER
Bulk Density PCF
154
152
150
148
% Void
2.5
2.0
1.5
1.0
0.5
Hveem Stability
40
30
20
10
% Asphalt
5.5
5.0
4.5
4.0
LEGEND
⊙ WHEEL TRACK
⊡ BETWEEN WHEEL TRACK
SECTION – A
B
C
A
B
C

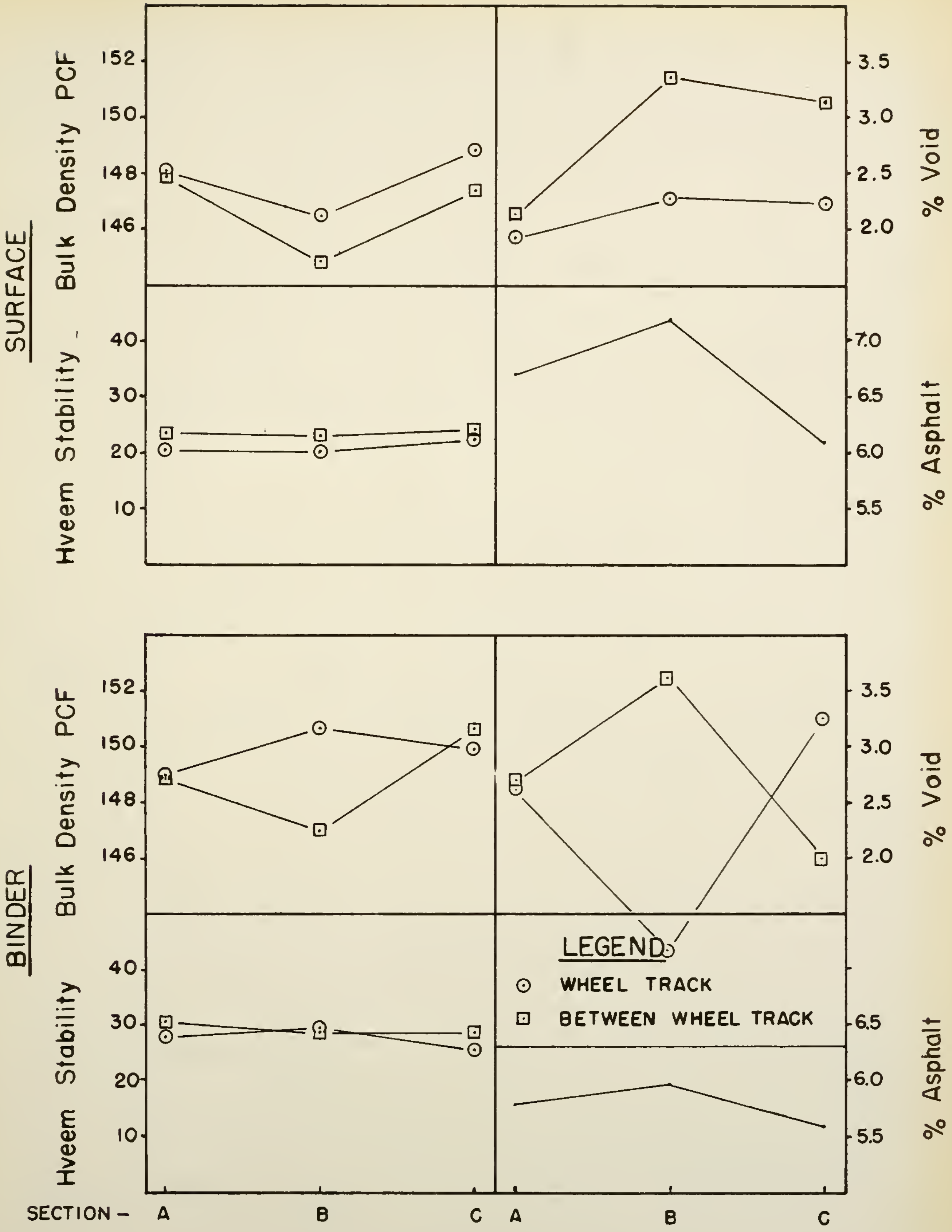
U.S. 36

Fig. 13


SURFACE
Bulk Density PCF
154
152
150
148
Hveem Stability
40
30
20
10
3.0
2.5
2.0
1.5
% Void
6.5
6.0
5.5
5.0
% Asphalt
BINDER
Bulk Density PCF
154
152
150
148
Hveem Stability
40
30
20
10
3.0
2.5
2.0
1.5
% Void
6.5
6.0
5.5
5.0
4.5
% Asphalt
LEGEND
⊙ WHEEL TRACK
⊡ BETWEEN WHEEL TRACK
SECTION —
A
B
C
A
B
C

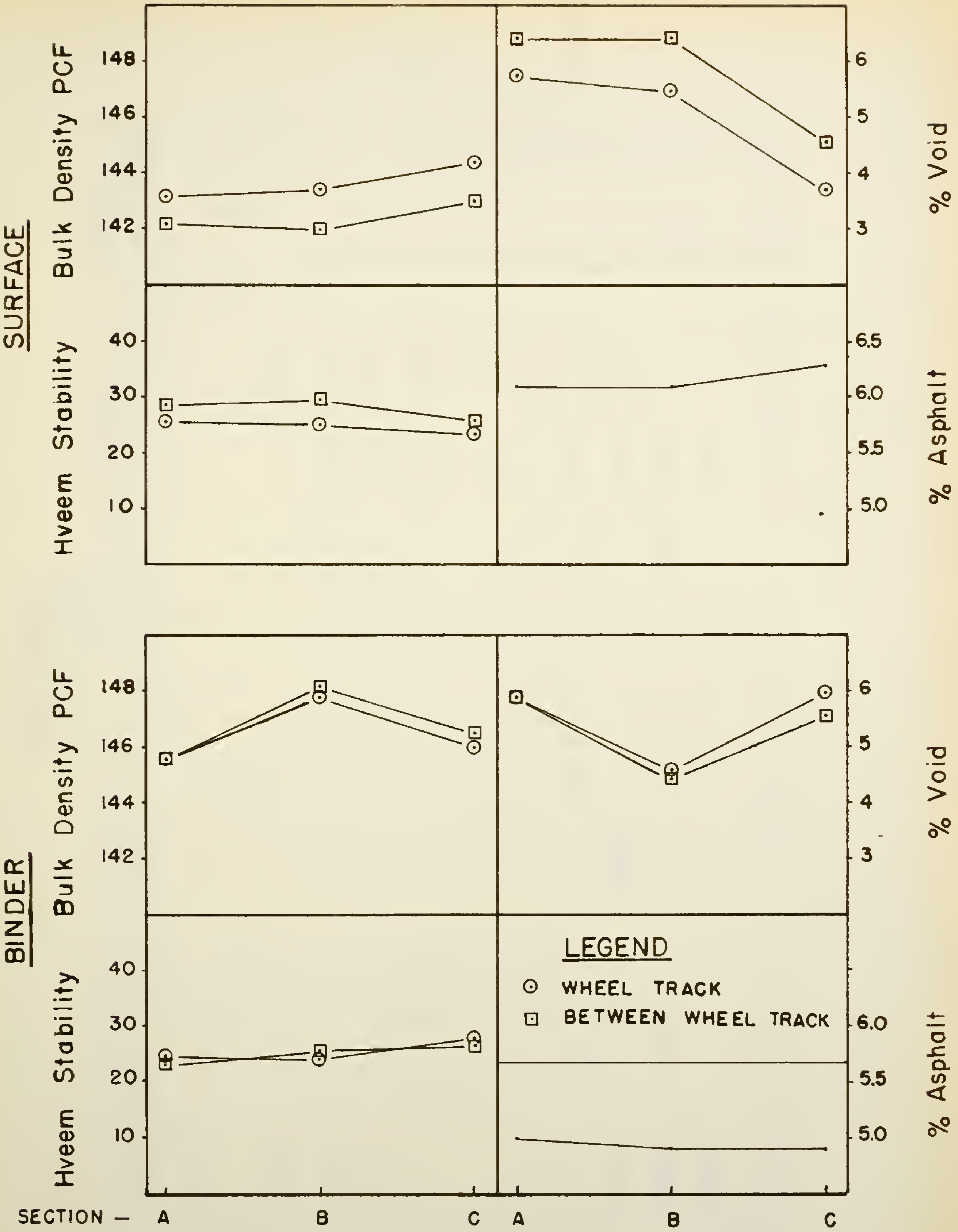
U.S. 136

Fig. 14


SURFACE
BINDER
Bulk Density PCF
Hveem Stability
% Void
% Asphalt
152
150
148
146
40
30
20
10
3.5
3.0
2.5
2.0
7.0
6.5
6.0
5.5
LEGEND
⊙ WHEEL TRACK
⊡ BETWEEN WHEEL TRACK
SECTION –
A
B
C

IND. 18

Fig. 15


SURFACE
Bulk Density PCF
148
146
144
142
% Void
6
5
4
3
Hveem Stability
40
30
20
10
% Asphalt
6.5
6.0
5.5
5.0
BINDER
Bulk Density PCF
148
146
144
142
% Void
6
5
4
3
Hveem Stability
40
30
20
10
% Asphalt
6.0
5.5
5.0
LEGEND
WHEEL TRACK
BETWEEN WHEEL TRACK
SECTION —
A
B
C
A
B
C

IND. 13

Fig. 16

TABLE 2

Sieve Analysis
% Passing (Ave.)

	U. S. 136		U. S. 36		Ind. 18		Ind. 13		Ind. 43	
Sieves	Surface	Binder	Surface	Binder	Surface	Binder	Surface	Binder	Surface	Binder
1 1/2"	—	—	—	100.0	—	—	—	—	—	—
1"	—	100.0	—	91.9	—	100.0	—	—	—	100.0
3/4"	—	89.2	—	78.3	—	87.1	—	100.0	—	95.8
1/2"	100.0	74.0	100.0	53.6	100.0	62.3	100.0	80.3	100.0	76.8
3/8"	92.5	56.3	94.8	39.7	87.3	47.0	96.8	56.9	88.4	58.5
#4	61.2	35.3	59.0	33.5	53.8	36.3	71.0	37.9	51.7	36.6
#6	49.2	31.9	49.6	32.6	48.3	34.0	62.2	34.2	43.6	40.0
#8	43.4	29.2	43.7	31.4	41.7	29.2	50.4	29.9	38.0	29.3
#16	33.7	22.1	32.2	25.6	29.3	20.9	33.2	21.5	28.6	22.8
#50	9.5	6.1	11.6	9.8	9.6	6.1	10.4	6.7	8.2	5.7
#100	6.8	3.4	6.1	4.6	5.3	4.4	8.5	3.3	5.3	3.3
#200	5.3	2.3	5.1	2.8	3.6	3.0	7.0	2.2	3.7	2.1
Pan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 3

Recompacted Pavement Test Results

U.S. 36

Samples	Foot Pressure PSI	Compaction Time min.	Hveem Stability	Bulk Density PCF
Surface	250	0	19.6	149.6
	350	3.5	30.0	147.9
	350	5.0	33.5	148.0
	500	2.0	25.0	147.8
	500	3.5	12.0	151.6
	500	5.0	9.8	152.6
Binder	350	3.5	26	151.6
	350	5.0	31.4	152.7
	500	3.5	33.5	153.8
	500	5.0	32.0	154.1

TABLE 3 (continued)

Recompacted Pavement Test Results

U. S. 136

Samples	Foot Pressure PSI	Compaction Time min.	Hveem Stability	Bulk Density PCF
Surface	350	5.0	27.2	146.58
	350	3.5	28.4	145.33
	500	5.0	18.5	147.07
	500	3.5	26.2	145.78
Binder	350	5.0	28.0	144.02
	350	3.5	28.5	144.70
	500	5.0	24.8	148.39
	500	3.5	27.8	146.70

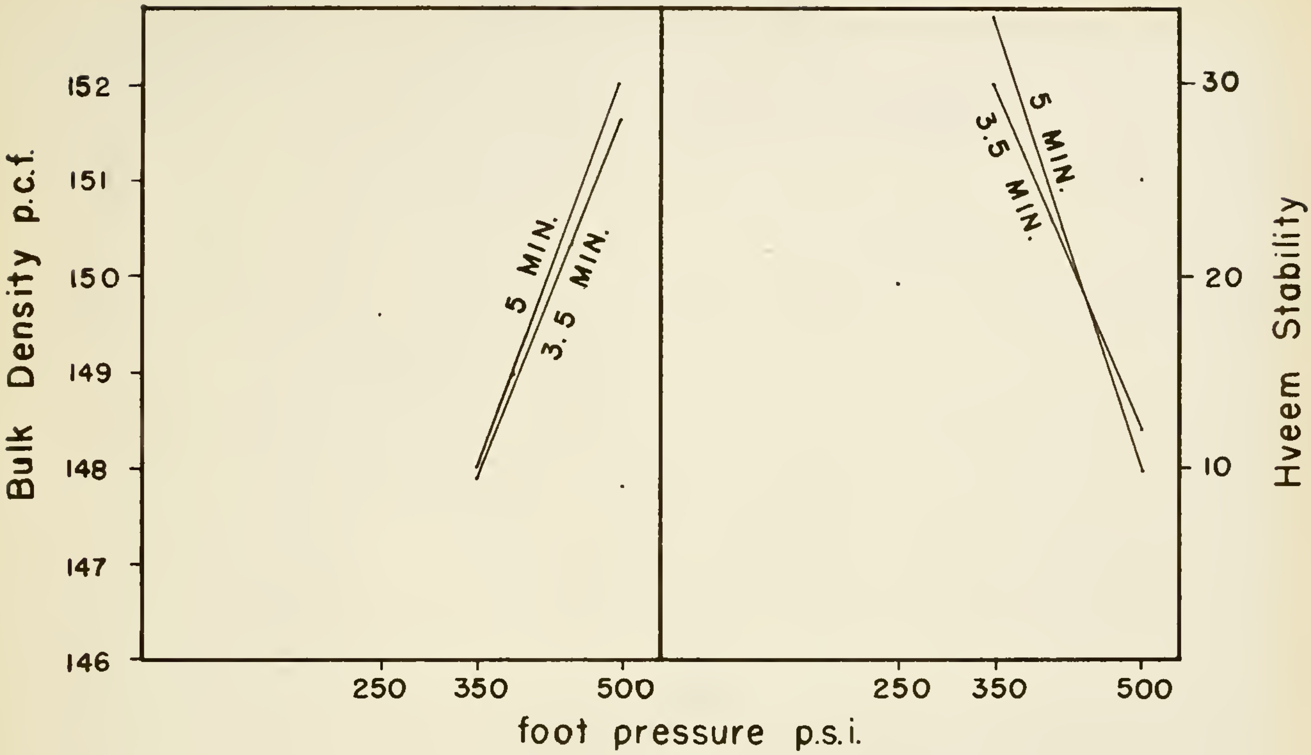
TABLE 3 (continued)

Recompacted Pavement Test Results

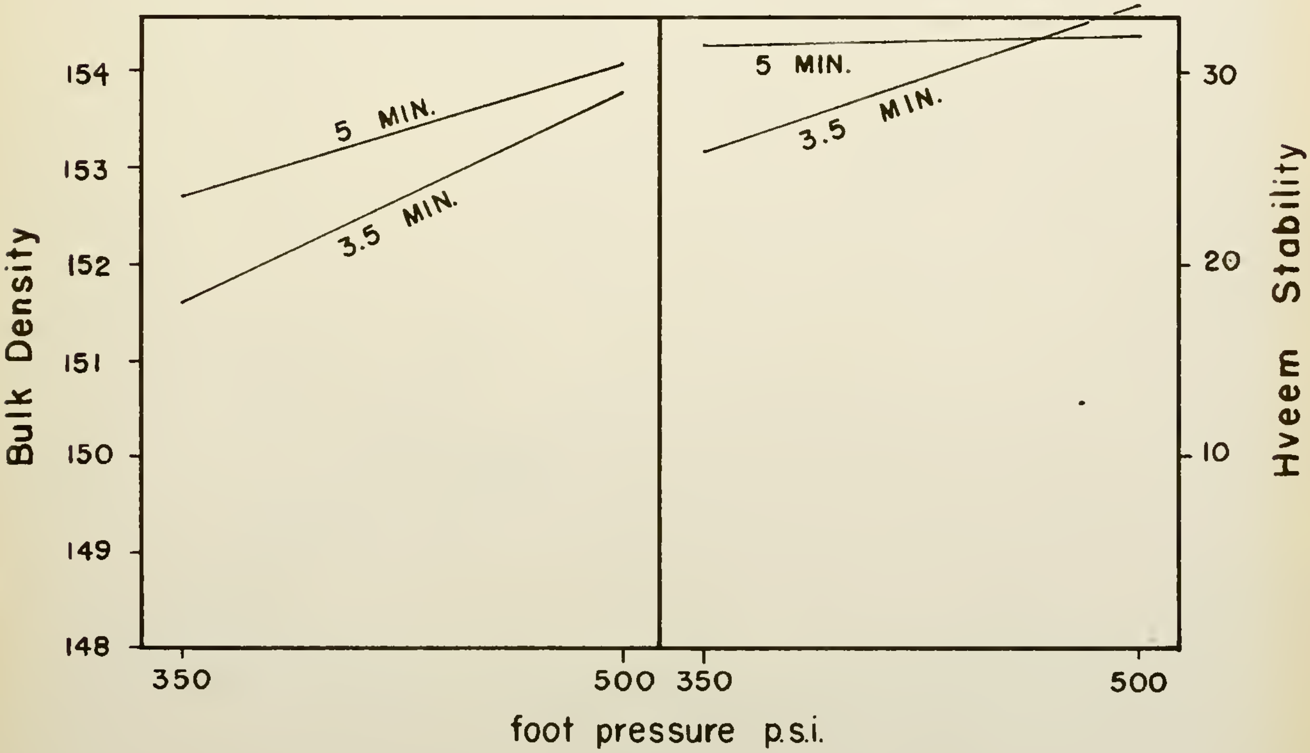
Ind. 13 @ U. S. 35

Samples	Foot Pressure PSI	Compaction Time min.	Hveem Stability	Bulk Density PCF
Surface	250	3.5	19.2	146.3
	250	5.0	29.7	146.6
	350	3.5	18.0	147.6
	350	5.0	20.5	147.5
	500	3.5	30.9	147.8
	500	5.0	31.7	148.5
Binder	250	3.5	27.0	144.6
	250	5.0	29.5	146.7
	350	5.0	29.8	146.8
	500	3.5	19.7	147.2
	500	5.0	25.0	148.0

RECOMPACTED PAVEMENT TEST RESULTS



Surface

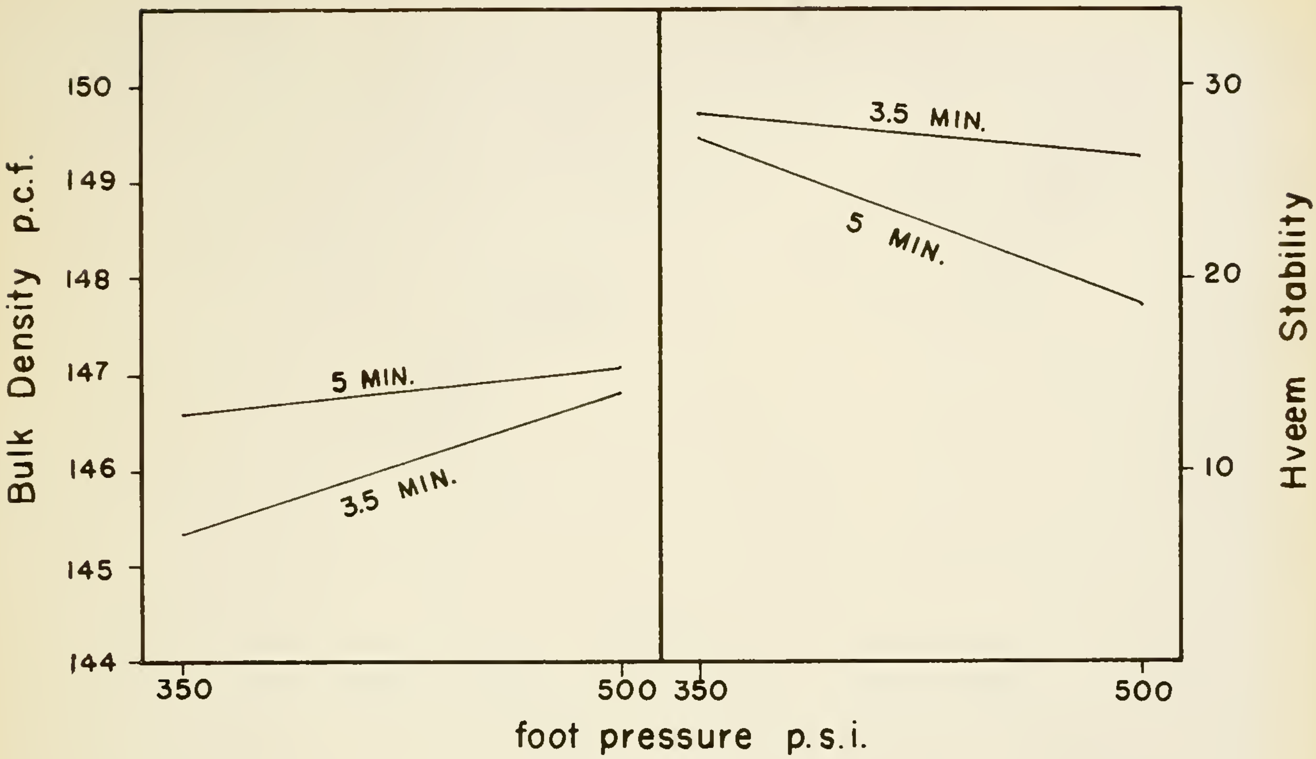


Binder

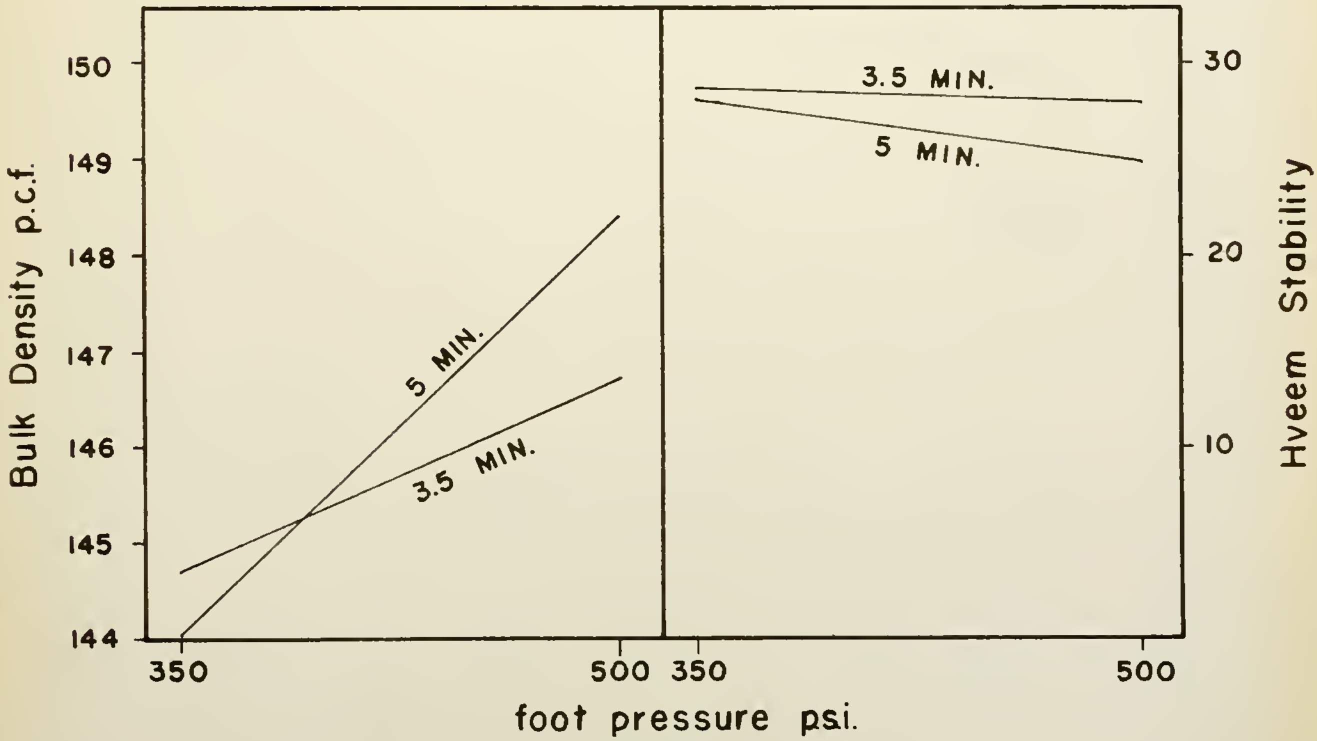
U.S. 36

Fig. 17

RECOMPACTED PAVEMENT TEST RESULTS



Surface

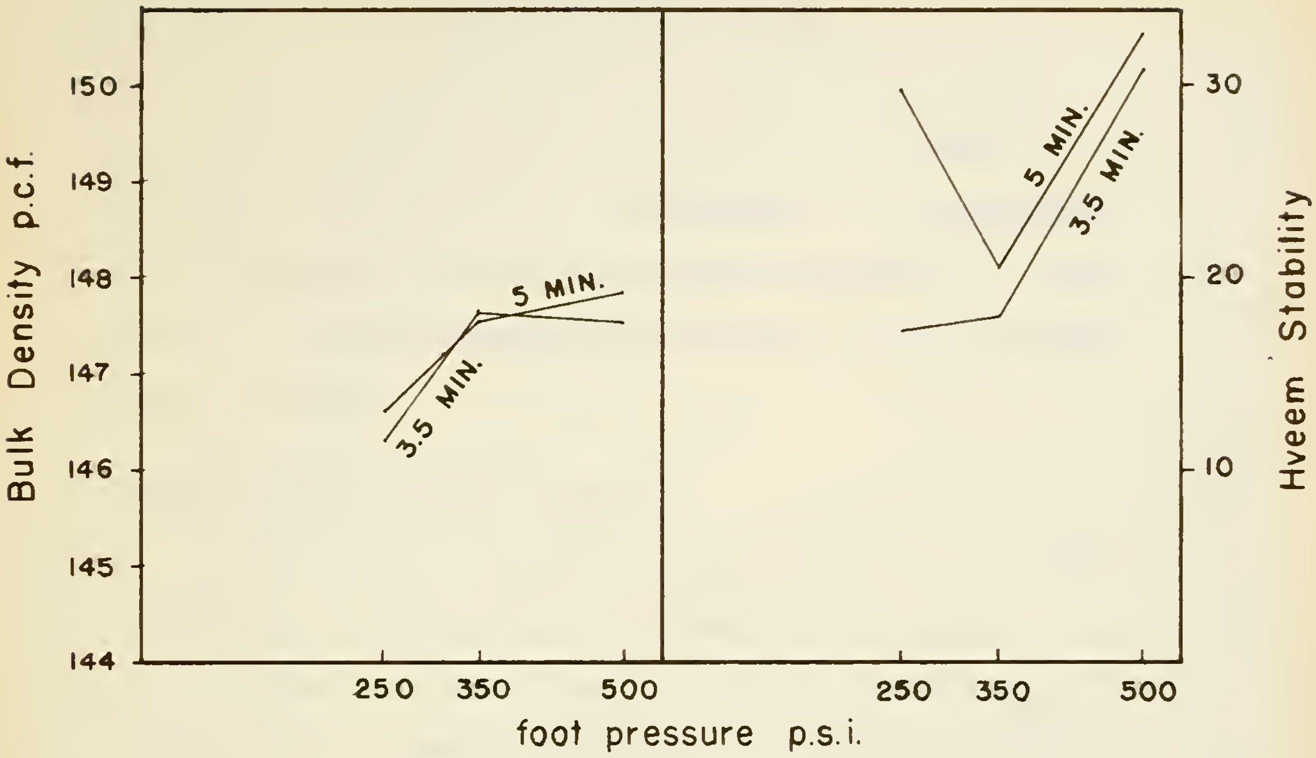


Binder

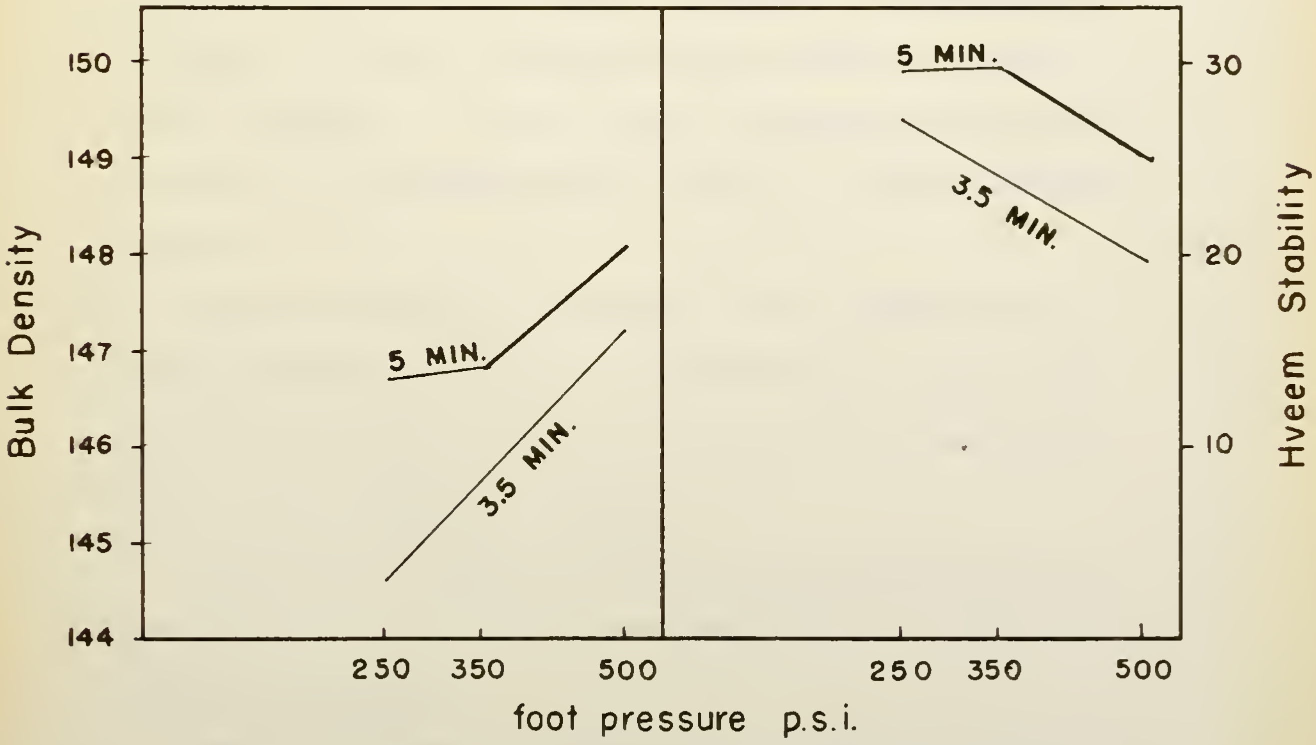
U.S. 136

Fig. 18

RECOMPACTED PAVEMENT TEST RESULTS



Surface



Binder

IND. 13

Fig. 19

RESULTS AND CONCLUSIONS

The following statements are presented as a resumé of findings resulting from this investigation. The field results are presented for all five sections which were cored. The laboratory results for recompacted specimens are limited to three of the locations.

Results of Tests on Core Specimens

Figures 12 to 16 illustrate the results of tests performed on built-up specimens for both surface and binder layers.

All Hveem stability values on surface and binder layers were less than 35, which is specified as a minimum stability in California for laboratory compacted mixtures to be subjected to high-volume traffic. Generally Hveem stability was low when density was high. For surface layer, all Hveem stability values were higher for between wheeltrack samples than for wheeltrack samples.

The surface density was higher in the wheeltrack than in between wheeltracks; however, the binder density did not vary in the same way, and there was no distinct pattern of density variation with respect to position.

High values of stability were obtained at high values of void content when the Rice maximum density values were used to compute void contents.

Table 2 presents the results of sieve analysis for the extracted aggregate samples for both binder and surface-layers.

Significant degradation, primarily of the material retained on No. 4 sieve is indicated for the surface layer of U. S. 136, U. S. 36, and Ind. 18 on the assumption that the mixture met specifications as placed. Based on the same assumption, there is also a significant increase in the minus 200 sieve material for the same locations.

Results of Tests on Recompacted Specimens

In this part of the study attempts were made to simulate the field condition of the pavement by varying the compaction effort. No attempt was made to establish the most suitable asphalt content by the Hveem design procedure. The compactive effort was changed both by number of tamps and foot pressure of the Kneading Compactor. Due to the lack of sufficient number of samples, the recompaction was not carried out to a wide range of variation in compactive effort.

Generally the data show, Figure 17 to 19, that as the compaction effort increased the densities of the surface and binder layers increased, but the stability generally decreased with increase in density. Of course, it has to be mentioned that the data are not sufficient and the range of variation of compactive effort is not wide enough to generalize this statement.

It can be noticed that the standard compaction pressure of 500 psi and 5 minute tamping has resulted in low values for Hveem stability and high values for density. The density values obtained under standard compaction procedure were close to maximum density. These laboratory test results indicate that the mixture would not

pass the standard Hveem stability and voids requirements commonly specified for design in California. Recompacted results also indicate that by variation of compactive effort densities close to field densities can be obtained, but such specimens will not have the same stabilometer values as field specimens. For example on U. S. 136, sample B-1 has a density of 147.1 pcf and stabilometer value of 27.4, while the same mix as a recompacted specimen has rendered a density of 141.1 pcf while its stability value is 18.5. The same is true with stabilometer value. When stabilometer values are the same, the densities are not close, such as in Ind. 13 where sample B-1 has a stabilometer value of 29.2 and density of 142.0 pcf while in the recompacted specimen, the stability is 29.7, and density 146.6. These discrepancies in corresponding values of density and stability may lead to the conclusion that kneading compaction does not produce specimens of the same structure as traffic compaction does. Of course, a more detailed investigation in this matter is required before establishing any fact in this respect.